The Periodic Table of the Elements
Alkali Metals
Teacher's Guide

Grade Level: 6–8 | **Curriculum Focus:** Physical Science | **Lesson Duration:** Two class periods

Program Description

Compared to other metals, alkali metals are soft and have low melting points and densities. But they are powerful in other ways: They react violently with water, releasing hydrogen and forming hydroxides, and they tarnish rapidly in dry air. A feature segment on fireworks illustrates the metals' explosive traits while tracing the human affinity for eye-popping, ear-blasting, multicolored displays.

Onscreen Questions

Part 1, "Exploring Alkali Metals," "Lithium: Aircraft Alloys," "Sodium: Salt from the Sea," and "Cesium: Atomic Clocks"

- What properties do the alkali metals share?
- What makes the alkali metals so chemically reactive?

Part 2, "The Insider's Guide to Fantastic Fireworks"

- How are fireworks projected into the air?
- Can you name some elements in fireworks and the functions they serve?

Lesson Plan

Student Objectives

- Identify basic properties of metals and the different types of metals.
- Find alkali metals on the periodic table and review their key properties.
- Discuss the use of alkali metals and other elements in the creation of fireworks.
- Create a mural of fireworks, highlighting at least five metals used to make the different colors and effects.

Materials

- *Alkali Metals* video
- Periodic table

- Large rolls of paper and markers to create murals
- Index cards (five for each group of students)
- Print and online resources about how fireworks are created
- Computer with Internet access

Procedures

1. Have students name some common metals and write their names and atomic symbols on the board. For example, iron (Fe), copper (Cu), Silver (Ag), platinum (Pt), gold (Au). Ask students to predict the common properties of metals and make a list of their answers. Most metals are:
    - hard
    - shiny
    - solid at normal temperature (except Mercury)
    - good conductors of heat and electricity
    - malleable (can be flattened into sheets)
    - ductile (can be stretched into long wires)
2. Next, show students where metals are found on the periodic table. Point out that there are different types of metals, each with unique properties: alkali metals, alkaline-earth metals, transition metals, and other metals. Metals can be identified on the periodic table by the columns, or groups, in which they're found. At this point, you may want to review with students how the periodic table is organized:
    - The elements are arranged in order of atomic number, or number of protons.
    - Elements in the same row, or period, are made of atoms with the same number of electron shells.
    - Elements in the same column, or group, are made of atoms with the same number of electrons in their outer shell. They also share similar properties.
3. Find the Alakali Metals (group 1) on the periodic table. How many electrons do these elements have in their outermost shell? (*one*) What effect does this have on these elements? (*They are inclined to lose their outer electron and therefore highly reactive*.) Using what they learned in the video, ask students to list the key properties of alkali metals:
    - Soft
    - Tarnish readily
    - Low melting points
    - Low densities
    - Violently reactive

4. Explain that the alkali metal sodium was used to create the first explosive. Two Chinese alchemists accidentally discovered the explosive by mixing charcoal, sulfur, and saltpeter—a sodium compound. Before long, explosives were used to create the first fireworks. While today's fireworks are far more complex, they still rely on alkali metals and other elements to create different colors and effects.
5. Tell students that they are going to work in small groups to research the different elements used to create fireworks. Then they will create a mural of a fireworks display highlighting at least five metals used to make the different colors and effects. At least one metal should be an alkali metal. Give each group a large sheet of paper, markers, and five large index cards. On each index card, they should provide information for one metal used in their fireworks display. The card should be placed on their mural next to the appropriate firework and include the following information:
    - Element Name and Atomic Symbol: [Copper (Cu)]
    - Type of metal: [Transition Metal]
    - Use or Effect: [Creates blue fireworks]
6. Provide students with print and online resources about fireworks, such as the following websites. They may want to begin with the first two websites to learn about different fireworks shapes and effects. The other two websites provide information about different elements used to create fireworks.
    - Create Your Own Fireworks
      http://www.fireworks.com/interactive/fireworks_show/default.asp
    - Starshell Glossary (Shapes of Fireworks)
      http://www.firework.co.nz/fireworks/starshell_glossary.htm
    - Chemistry of Fireworks
      http://www.fireworks.com/safety/chemistry-fireworks.asp
    - Pyrotechnics: It's Elemental
      http://www.pbs.org/wgbh/nova/kaboom/elemental/
7. Once students have completed their murals, have each group present their fireworks display to the class.

Assessment

Use the following three-point rubric to evaluate students' work during this lesson.

- 3 points: Students were active in class discussions; showed a strong understanding of metals, alkali metals, and the periodic table; developed a creative, attractive, and varied mural highlighting at least five metals; index cards identifying metals were accurate and complete.
- 2 points: Students participated in class discussions; showed a satisfactory understanding of metals, alkali metals, and the periodic table; developed an acceptable mural highlighting five metals; index cards identifying metals were mostly accurate and complete.

- 1 point: Students did not participate in class discussions; showed a weak understanding of metals, alkali metals, and the periodic table; developed an complete or sloppy mural highlighting less than metals; index cards did not accurately identify metals or were incomplete.

Vocabulary

alkali metal

Definition: A highly reactive metallic element belonging to group 1 of the periodic table, including: lithium, sodium, potassium, rubidium, cesium, and francium

Context: The alkali metals are as soft as cold butter and much less dense than most other metals.

element

Definition: A substance that is composed of one type of atom; an element cannot be chemically separated

Context: Sodium is the sixth most abundant element on Earth.

reactive

Definition: Taking part in a chemical reaction, as in an element

Context: Alkali metals are so reactive that they interact with most other elements they come into contact with.

valence electrons

Definition: The electrons in an atoms outermost electron shell that dictate how elements interact

Context: The single valence electron in the alkali metals makes them very unstable and they easily lose this electron to other elements.

Academic Standards

Mid-continent Research for Education and Learning (McREL)
McREL's Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education addresses 14 content areas. To view the standards and benchmarks, visit http://www.mcrel.org/compendium/browse.asp.

This lesson plan addresses the following national standards:

- Science—Physical Sciences: Understands the structure and properties of matter

National Academy of Sciences

The National Academy of Sciences provides guidelines for teaching science in grades K–12 to promote scientific literacy. To view the standards, visit this Web site: http://books.nap.edu/html/nses/html/overview.html#content.

This lesson plan addresses the following science standards:

- Physical Science
- Science and Technology

Support Materials

Develop custom worksheets, educational puzzles, online quizzes, and more with the free teaching tools offered on the Discoveryschool.com Web site. Create and print support materials, or save them to a Custom Classroom account for future use. To learn more, visit

- http://school.discovery.com/teachingtools/teachingtools.html

DVD Content

This program is available in an interactive DVD format. The following information and activities are specific to the DVD version.

How to Use the DVD

The DVD starting screen has the following options:

***Play Video*—** This plays the video from start to finish. There are no programmed stops, except by using a remote control. With a computer, depending on the particular software player, a pause button is included with the other video controls.

Video Index—Here the video is divided into sections indicated by video thumbnail icons; brief descriptions are noted for each one. Watching all parts in sequence is similar to watching the video from start to finish. To play a particular segment, press Enter on the remote for TV playback; on a computer, click once to highlight a thumbnail and read the accompanying text description and click again to start the video.

***Curriculum Units*—** These are specially edited video segments pulled from different sections of the video (see below). These nonlinear segments align with key ideas in the unit of instruction. They include onscreen pre- and post-viewing questions, reproduced below in this Teacher's Guide. Total running times for these segments are noted. To play a particular segment, press Enter on the TV remote or click once on the Curriculum Unit title on a computer.

***Standards Link*—** Selecting this option displays a single screen that lists the national academic standards the video addresses.

***Teacher Resources*—** This screen gives the technical support number and Web site address.

Video Index

I. Exploring Alkali Metals (5 min.)
Much less dense than most other metals, alkali metals are also extremely chemically reactive. Learn about their shared properties and many different uses.

II. Lithium: Aircraft Alloys (5 min.)
The lightest of all metallic elements, lithium serves many purposes. See why it is an ideal partner for aluminum in aircraft alloys.

III. Sodium: Salt From the Sea (7 min.)
See how the people of Catalina Island solved their drinking water shortage by removing salt from the seawater that surrounds them.

IV. Cesium: Atomic Clocks (6 min.)
Examine this reactive metal and the important role it plays in calibrating atomic clocks and global positioning systems.

V. The Insider's Guide to Fantastic Fireworks (22 min.)
Fireworks are used in many cultural celebrations. Discover how they are made and learn about advancements in pyrotechnic technology.

Curriculum Units

1. All About Alkali Metals
Pre-viewing question
Q: What makes alkali metals different from most other metals?
A: Alkali metals are softer, much less dense than most other metals, and they are more reactive.

Post-viewing question
Q: What are some uses for alkali metals?
A: Possible answers may include that lithium is sometimes used to make lightweight steel alloys for aircraft. Sodium's uses range from table salt to batteries. Potassium goes into glass, soap, and explosives. Rubidium is used in heart research and for making photoelectric cells. Scientists use cesium to help calibrate atomic clocks. Francium occurs as a radioactive byproduct of uranium decay.

2. Lithium and Its Uses
Pre-viewing question
Q: What do you know about lithium?
A: Answers will vary.

Post-viewing question
Q: What are some common uses of lithium?
A: Lithium is commonly used in lubricants or combined with other metals to increase the strength of metal alloys, and it is an element in batteries. Lithium salt can act as a stimulant in the human brain that may help relieve depression.

3. Lithium and Aluminum 1:14:22-1:16:46
Pre-viewing question
Q: How have aircraft design and technology changed over the years?
A: Answers will vary.

Post-viewing question
Q: Why is lithium an ideal element to add to aluminum when making plane and spacecraft parts?
A: Aluminum is light and resists corrosion well, but it is too weak and bendable to be used by itself. The chemical properties of lithium make it an ideal metal to add to aluminum. Since lithium is the lightest metallic element, its alloys are also very light. But lithium's chemical properties make these alloys very strong and resistant to fatigue.

4. Sodium and Its Uses
Pre-viewing question
Q: What are some uses of sodium?
A: Possible answers include table salt; the making of glass and batteries; and an element in streetlights, nuclear reactors, and medicine.

Post-viewing question
Q: Describe the characteristics of a typical sodium atom.
A: Each atom of sodium consists of a cloud of electrons surrounding a compact nucleus that contains almost all of the atom's mass. In the most common form of sodium, its nucleus has 11 positively charged protons, 12 uncharged neutrons, and 11 negatively charged electrons to balance its protons. The electrons are found in three shells surrounding the nucleus. Pure sodium has a silvery-white appearance but tarnishes easily in moist air.

5. Making Drinking Water
Pre-viewing question
Q: What factors affect the amount of drinking water available to a region?
A: Answers will vary.

Post-viewing question
Q: Describe the desalination process used on Catalina Island.
A: The desalination plant on Catalina Island uses the process of reverse osmosis: High-pressure pumps push seawater through a semipermeable membrane, and the salts and other minerals are left behind.

6. Cesium and Its Uses
Pre-viewing question
Q: What do you know about cesium?
A: Answers will vary.

Post-viewing question
Q: What makes cesium a unique metal?
A: Cesium is the most alkaline of all the elements on the periodic table and only one of three metals

that are liquid at room temperature. Highly reactive, cesium explodes when it comes into contact with cold water and even reacts when it comes into contact with light rays.

7. Keeping Time With Cesium
Pre-viewing question
Q: What would life would be like without an accurate way to measure time?
A: Answers will vary.

Post-viewing question
Q: How do cesium atomic clocks works?
A: Cesium atomic clocks measure the vibration of the outer electrons within a beam of cesium atoms. Cesium atoms vibrate steadily at a rate of more than 9 million cycles per second. As cesium atoms pass through a magnetic field, the frequency of their vibrations can be used to calibrate the ticking of a clock. Put into use in 1955, the first cesium clock is estimated to gain or lose less than a second every three million years and newer cesium clocks are even more accurate.

8. Preparing the Fireworks
Pre-viewing question
Q: What do you like or dislike about fireworks?
A: Answers will vary.

Post-viewing question
Q: Describe the best fireworks display you have ever seen.
A: Answers will vary.

9. Setting Off Firecrackers
Pre-viewing question
Q: Have you ever lit fireworks or firecrackers?
A: Answers will vary.

Post-viewing question
Q: How do firecrackers work?
A: The common firecracker is comprised of a powdery combination of saltpeter, sulfur, and charcoal. When a fuse burns into a mass of this black powder an incredibly rapid chemical reaction takes place. Saltpeter acts like gasoline to the flammable mixture of sulfur and charcoal, resulting in an explosion that blows the cardboard tube apart.

10. Movie Pyrotechnics
Pre-viewing question
Q: What is the most realistic special effects sequence you've seen in a movie?
A: Answers will vary.

Post-viewing question
Q: What are some safety concerns about using pyrotechnics in a movie?
A: Answers will vary.

11. A Fireworks Dynasty at Work
Pre-viewing question
Q: What skills are necessary to be a good pyrotechnician?
A: Answers will vary.

Post-viewing question
Q: What safety precautions are taken at the Rozzi factory?
A: At the Rozzi factory no one is allowed to smoke, use matches, or light flames near the premises. The workers are constantly on guard against static electricity; each building is armed with a grounding plate to keep a spark of static electricity at bay. The work shacks are built to fall apart in an explosion, which would reduce injury from the concussion of a blast, and they are spaced far apart to prevent fire from spreading.

12. Fireworks Displays
Pre-viewing question
Q: What would you like to witness in a fireworks display?
A: Answers will vary.

Post-viewing question
Q: How have computers enhanced our ability to create fireworks displays?
A: Instead of relying on fuses to light fireworks, we can use electrical wires. When hot with current, a small strip of wire within each lift causes fireworks to charge skyward. The fireworks are numbered and their wires are electrically linked to a switching box, which is connected to a computer that can fire any firework at any time, or dozens at the same time.